INDOOR AIR QUALITY ASSESSMENT

Hopedale Middle/High School
25 Adin Street
Hopedale, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Leonard Izzo of the Hopedale Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at Hopedale Middle/High School. The request was prompted by concerns about mold as a result of excessively humid weather during the first three weeks of August 2003.

On September 17, 2003, a visit was made to this school by Cory Holmes, Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program, to conduct an indoor air quality assessment with a primary focus on mold. Mr. Holmes was accompanied by Phil Rinehart, Director of Buildings and Grounds, Hopedale School Department (HSD) and Mr. Izzo. The school had been visited by BEHA several times since March of 2000. A number of reports/correspondence have been issued detailing indoor air quality conditions in the school (MDPH, 2000a; MDPH, 2000b; MDPH, 2000c; MDPH, 2002). As discussed, the primary concern prompting this assessment was in relation to mold growth, however, since building renovations have taken place subsequent to the last complete BEHA IAQ report being issued, a general IAQ assessment was conducted.

Methods

BEHA staff performed visual inspection of building materials for water damage and/or microbial growth. Moisture content of carpeting was measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school has a student population of approximately 400 and a staff of approximately 65. The tests were taken during normal operations at the school. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million of air (ppm) in fifteen of nineteen areas surveyed, indicating adequate ventilation in most of the areas surveyed. It is important to note however, that classrooms are equipped with air conditioning, which limits outside air intake on hot, humid days (as was the case during this assessment). Limiting outside air intake can contribute to an increase in carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 1) and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated or cooled and provided to classrooms through an air diffuser located in the top of the unit. Adjustable louvers control the ratio of outside to recirculated air. As mentioned, during the air conditioning season, outside air is limited in order to maximize cooling and decrease humidity. Mr. Rinehart removed the panel to the univent to show that the univent control was set to minimal airflow (Picture 2).

Univents were deactivated in some classrooms, however, Mr. Rinehart reactivated the units during the assessment. In order for univents to provide fresh air as designed, these units must remain activated and allowed to operate while rooms are occupied. In addition, air diffusers and return vents must remain free of obstructions. Obstructions to airflow, such as papers and books stored on univents were also seen in a number of classrooms (Picture 3).

The mechanical exhaust ventilation system consists of ceiling-mounted exhaust vents connected to rooftop motors. This system was operating during the assessment. However, the location of some exhaust vents, near hallway doors, can limit exhaust efficiency when classroom doors are open (Picture 4). When a classroom door is open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms.

Fresh air in interior classrooms is provided by rooftop air-handling units (AHUs) and ducted to classrooms via ceiling-mounted air diffusers. Return air is drawn into wall or ceiling vents back to the AHU. These systems were functioning during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The initial equipment balancing should have occurred after the installation of the new HVAC systems. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix I.

Temperature measurements ranged from 70^{o} F to 74^{o} F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 51 to 59 percent, which was also within the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989). Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

In the experience of BEHA staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. In general, materials that are prone to mold growth can become colonized when moistened for more than 24-48 hours. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August (The Weather Underground, 2003), materials in a large number of schools and buildings were moistened for an extended period of time. Carpeting in the computer room was reportedly shampooed the first week in August and the room was closed up for several weeks prior to the first day of school. The carpet was not dried with mechanical aids (e.g. fans, dehumidifiers); as a result, mold growth occurred on the surface of carpeting. The HSD hired National Cleaning Corporation, a professional carpet-cleaning firm to clean and disinfect carpeting. No evidence of active mold growth, elevated moisture content or associated odors detected on or underneath carpeting at the time of the assessment. BEHA staff did however observe what appeared to be mold growth on the base of cinderblock walls behind rubber coving (Picture 5). In a subsequent conversation with Mr. Rinehart, he reported that the carpet is scheduled to be removed over the Christmas break (2003-2004) to eliminate any potential of mold growth reoccurring.

The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24-48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Classroom 214 had plants on top of paper towels that were saturated with water (Picture 6). Plants should be equipped with drip pans. Paper plates and towels are porous materials that can be colonized by microbial growth, especially if wetted repeatedly. In addition, the lack of drip pans can lead to water pooling and mold growth on windowsills. Plants are also a source of pollen. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

An open utility hole in the exterior wall (Picture 7), which can provide a potential pathway for moisture into the building was also seen. Repeated water penetration can result in the chronic wetting of building materials and potentially lead to microbial growth. In addition breaches in the building envelope may provide a means of egress for pests/rodents into the building.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. Accumulated dry erase particulate was noted in some classrooms, which can also serve as a source of airborne particulates.

A number of exhaust/return vents were noted with accumulated dust (Picture 8). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 9). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and lead to off gassing of VOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix II (NIOSH, 1998).

Finally, occupants expressed concerns relative to the adequacy of ventilation for the flammable storage cabinets (Picture 10). The National Fire Protection Association (NFPA) does not require venting in flammable storage cabinets. However, it is recommended that if a flammables storage cabinet is connected to a vent system, the vent system should not be constructed in a manner to provide an oxygen source to the interior of the cabinet and it must be vented directly outdoors and not in a manner which might compromise the specific performance of the cabinet (NFPA, 1996). It could not be determined during the assessment if the flammable cabinet had a mechanical exhaust fan in the ductwork or a damper to prevent backdrafting.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Although cleaning has eliminated microbial growth from the carpet presently, further growth can be expected to occur once water moistens carpet in below grade areas. To avoid this occurrence, continue with plans to remove carpeting from below grade areas where mold was detected prior to the cleaning.
2. Remove rubber baseboard coving during carpet removal and examine walls for fungal growth. If colonized, disinfect areas of surface mold with bleach and water solution, followed by wet wiping of soap and water.
3. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
4. Ensure univent air intakes controls are adjusted to allow the introduction of fresh air.
5. Remove all blockages from univents to ensure adequate airflow.
6. Confirm whether the ventilation systems were balanced as part of the recent renovations. If they have not been balanced, consult a ventilation engineer concerning balancing of the systems. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize

common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g. throat and sinus irritations).

8. Move plants away from univents in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary. Consider reducing the number of plants.
9. Seal hole in exterior wall (Picture 7) to prevent water intrusion and entry of pests.
10. Clean chalkboards and dry erase board trays regularly to avoid the build-up of particulates.
11. Clean exhaust/return vents periodically to prevent excessive dust build-up.
12. Determine if flammable cabinets are vented in a manner consistent with NFPA recommendations. If not, consider removing ductwork and seal cabinet to render airtight.
13. Consider discontinuing the use of tennis balls on chairs to prevent latex dust generation.
14. In order to maintain a good indoor air quality environment on the building, consideration should be give to adopting the US EPA document, "Tools for Schools". This document can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
15. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

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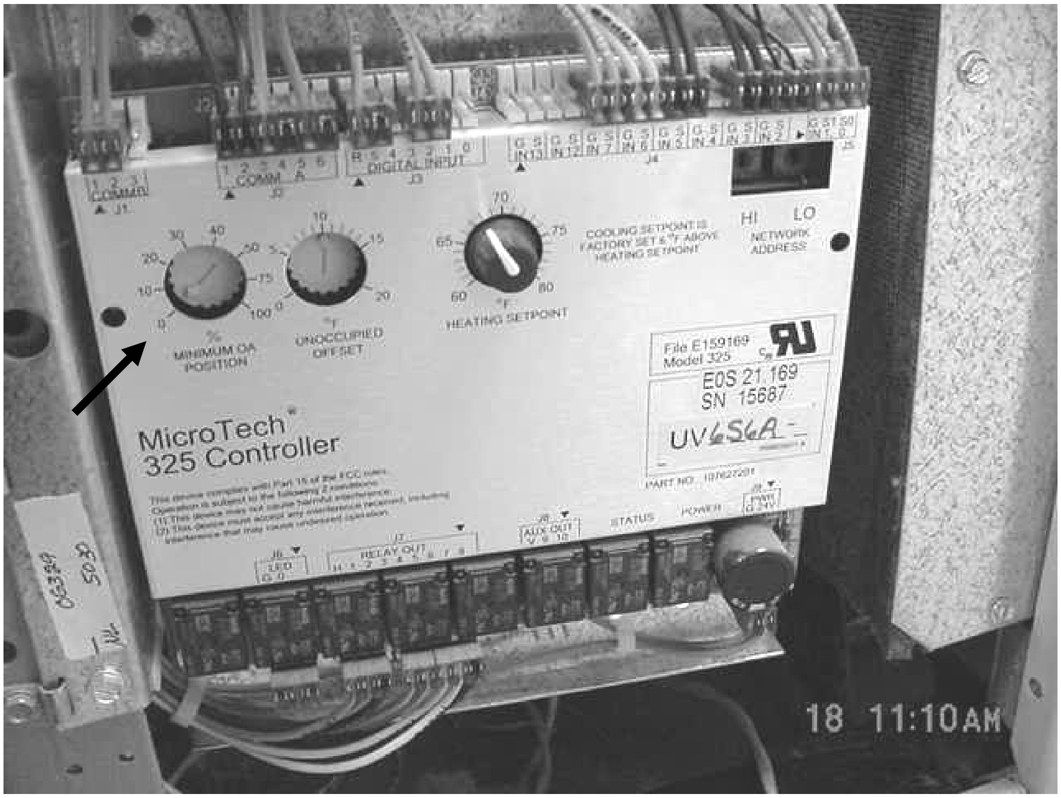
Picture 1

Univent Outside Air Intake

Picture 2



Univent Airflow Control set to Minimal Position

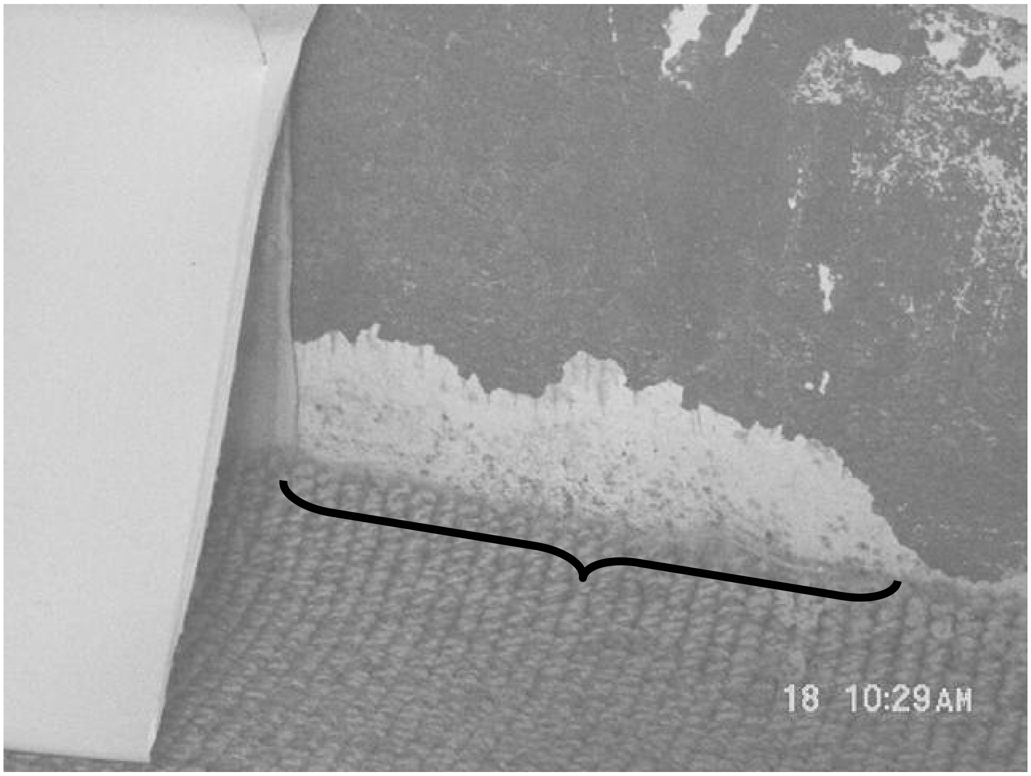
Picture 3

Classroom Items on top of Univent Air Diffuser

Picture 4

Ceiling Exhaust Vent Near Open Classroom Door

Picture 5



Possible Mold Growth on Cinderblock Walls Behind Rubber Coving

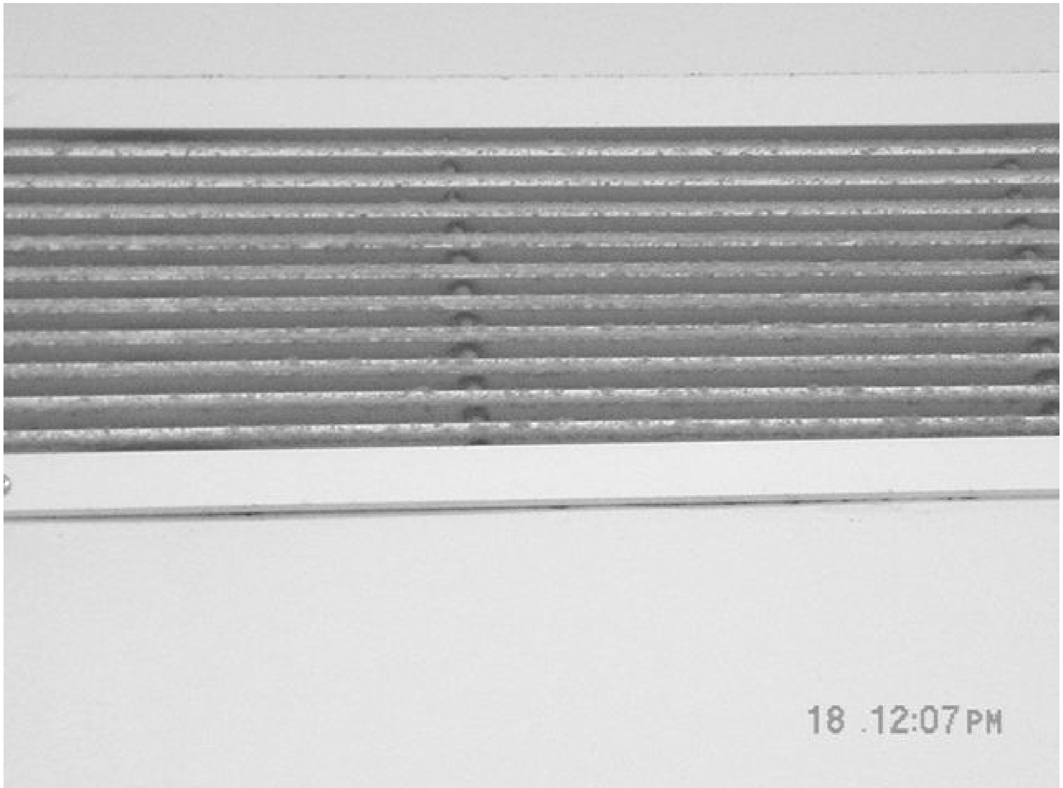
Picture 6

Plant on Saturated Paper Towels

Picture 7

Hole in Exterior Wall

Picture 8



Accumulated Dust on Return Vent in Music Room

Picture 9

Tennis Balls on Chair Legs in Classroom

Picture 10

Vented Flammable Cabinet in Science Prep Room

TABLE 1

Indoor Air Test Results – Hopedale Middle/Senior High School – Hopedale, MA September, 17, 2003

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	440	71	55					*Cool, scattered cloud, light breeze
Room 114	600	70	58	0	Y	Y	Y	*Surface mold on cement wall behind rubber coving Low moisture content-carpeting
Room 124	753	72	59	14	Y	Y	Y	*Items on UV *Non flam in flam cabinet cardboard/plastic bags
Room 233	782	72	54	20	Y	Y	Y	*Deb particulate *Door open (DO) *Exhaust near doorway
Room 232	1200	72	55	24	Y	Y	Y	
Room 231	900	73	55	24	Y	Y	Y	
Room 230	731	74	53	0	Y	Y	Y	*UV – deactivated, reactivated by Mr. Rinehart
Room 287	750	78	51	8	Y	Y	Y	
Room 751	567	71	55	3	Y	Y	Y	

*** ppm = parts per million parts of air**
***CT = Ceiling Tile**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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Indoor Air Test Results – Hopedale Middle/Senior High School – Hopedale, MA **September, 17, 2003**

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Room 220	733	71	50	2	Y	Y	Y	*Plants *DO *4 OCC gone 10 min.
Room 214	655	78	50	1	Y	Y	Y	*Deb particulate *Plants over watered-on paper towels
Room 204	618	78	57	16	Y	Y	Y	*DO
Room 247	675	73	56	12	Y	Y	Y	*1 CT around sprinkler
Room 535	539	71	53	4	Y	Y	Y	*Flam cabinet vented
Room 121 (Wood Shop)	588	71	51	3	Y	Y	Y	
Room 105 (TV production)	747	71	55	9	Y	Y	Y	
Media Center	620	72	56	5	Y	Y	Y	*Plants
Room 144	836	72	53	10	Y	Y	Y	*2 MT *Plants

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						Supply	Exhaust	
Cafeteria	894	70	56	~200	N	Y	Y	
Music Room	669	78	58	0	N	Y	Y	*Return vents dusty

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